US009106119B2

(12) **United States Patent**
Kaiser et al.

(10) **Patent No.: US 9,106,119 B2**
(45) **Date of Patent: Aug. 11, 2015**

(54) **SUPPORT RING FOR ELECTRIC MACHINE ROTORS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 615 days.

(21) Appl. No.: **13/331,361**

(22) Filed: **Dec. 20, 2011**

(65) **Prior Publication Data**

US 2013/0154437 A1 Jun. 20, 2013

(51) **Int. Cl.**

H02K 1/22	(2006.01)
H02K 1/24	(2006.01)
H02K 1/30	(2006.01)
H02K 3/52	(2006.01)

(52) **U.S. Cl.**

CPC ***H02K 3/527*** (2013.01); ***H02K 1/24*** (2013.01); ***H02K 1/30*** (2013.01); *H02K 2203/12* (2013.01)

(58) **Field of Classification Search**

CPC H02K 3/51; H02K 3/527; H02K 3/528; H02K 55/04

USPC 310/216.114, 216.121, 260, 263, 270, 310/400

See application file for complete search history.

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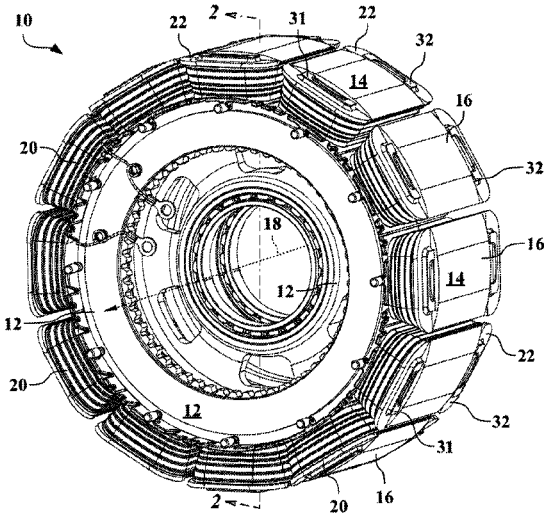
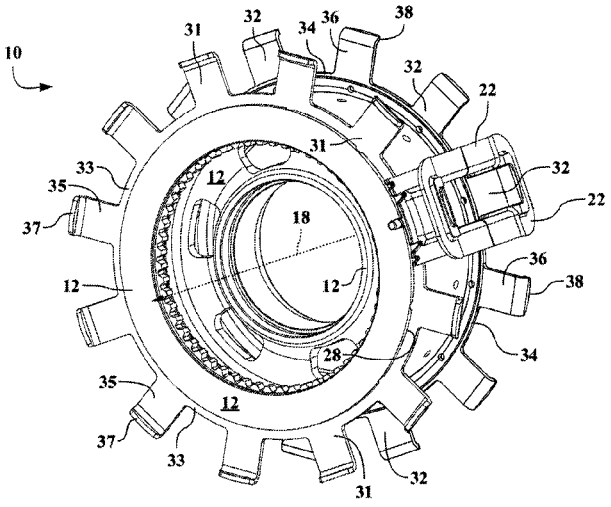
(57) **ABSTRACT**

A support ring for a rotor having a core and a plurality of windings. The support ring includes an annular base, a plurality of fingers, and a plurality of loaded edges. The plurality of fingers extend radially outward from the annular base, and each generally corresponds to one of the windings. The plurality of loaded edges extend axially from the fingers and are disposed radially outward of the windings.

11 Claims, 6 Drawing Sheets





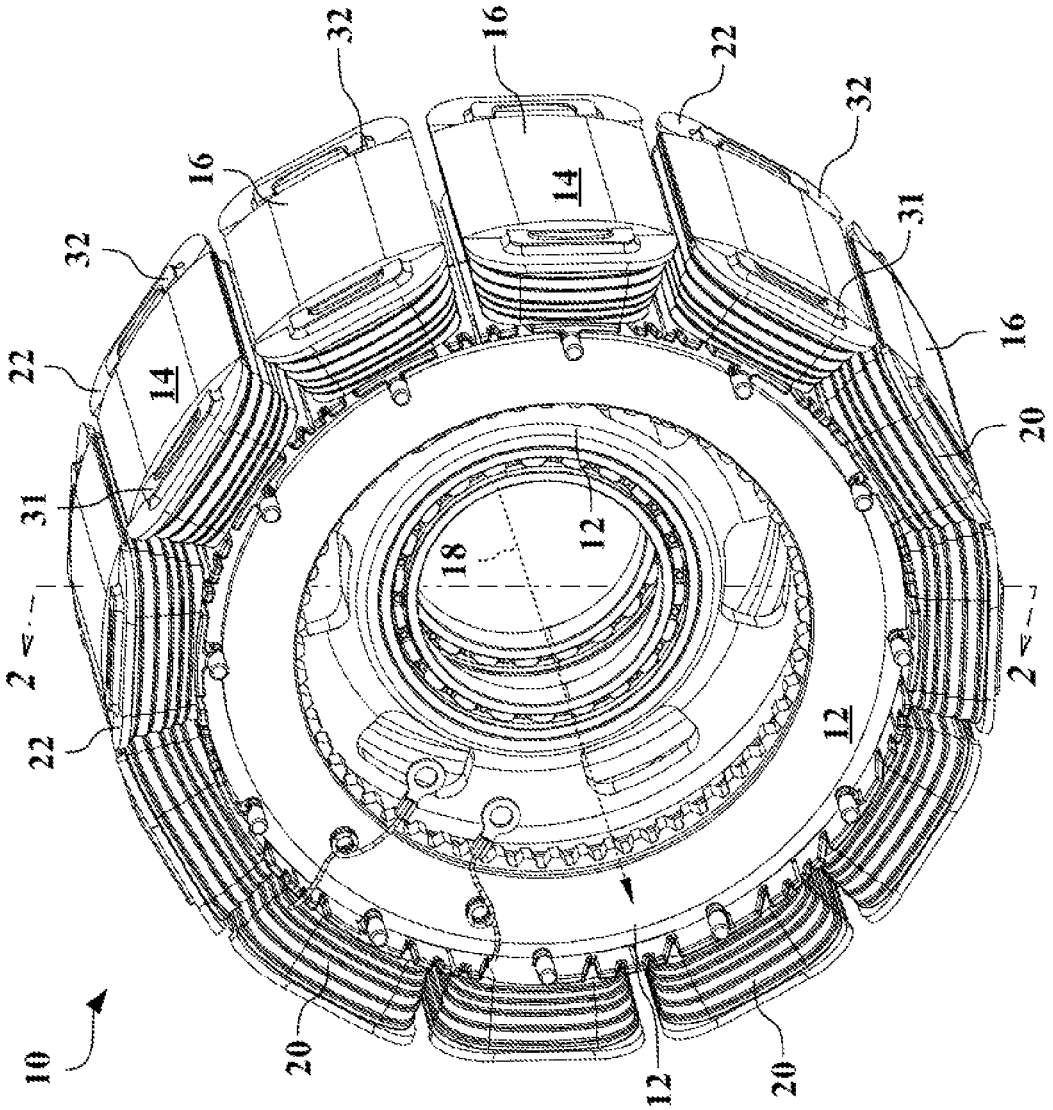


Figure 1

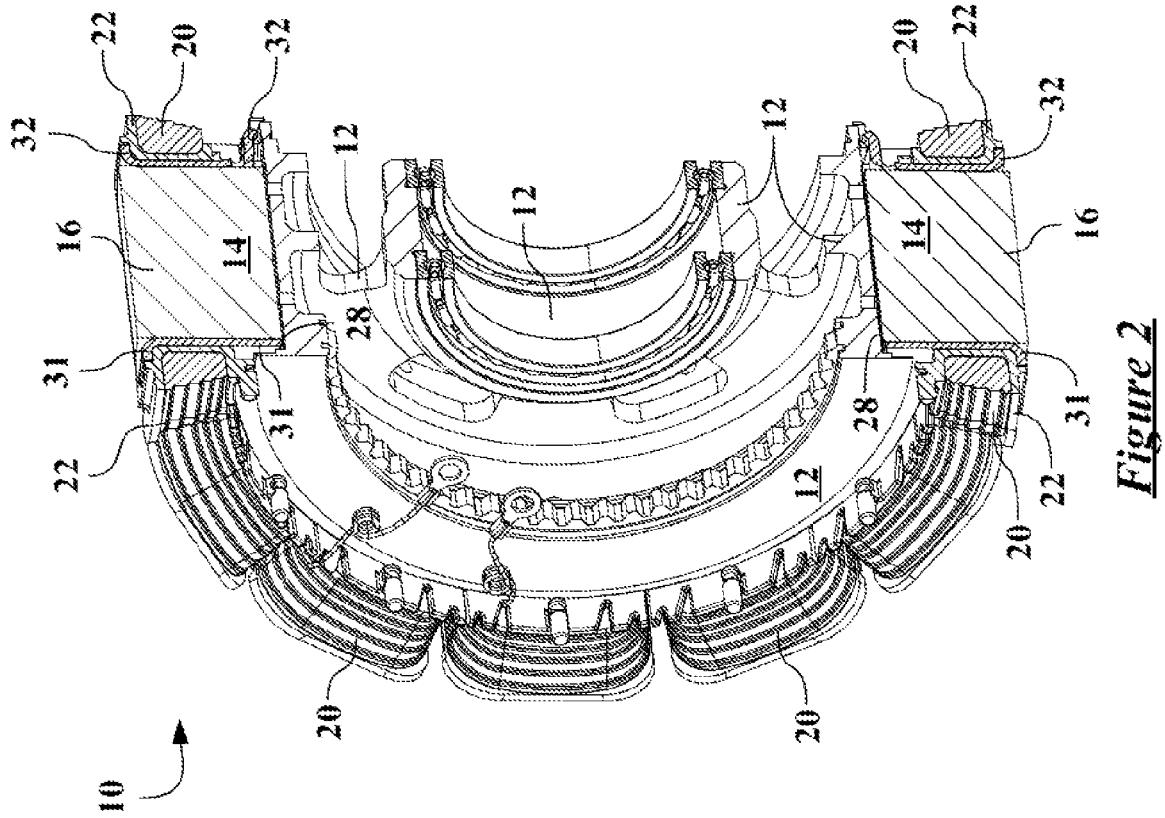


Figure 2

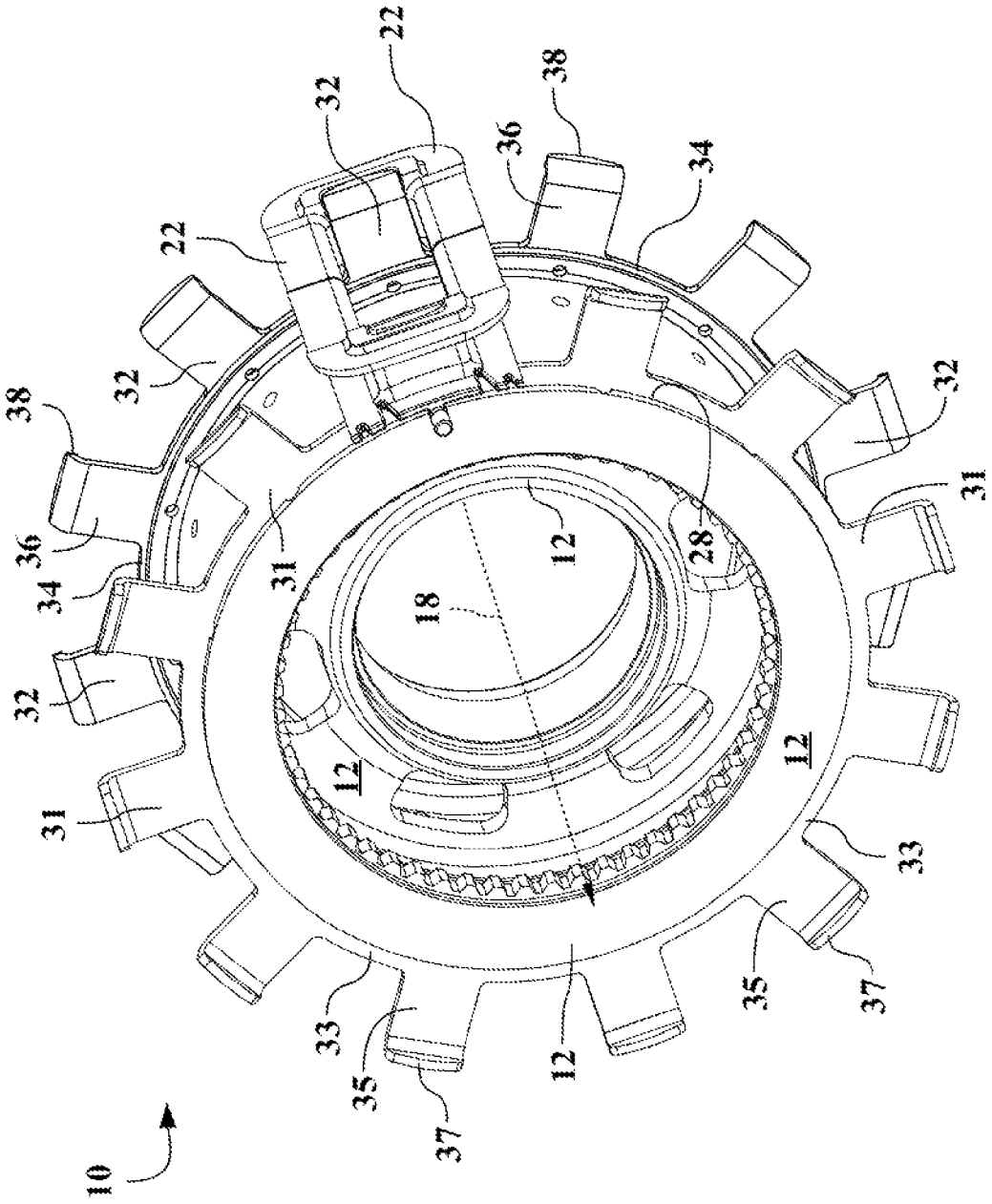

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Figure 3

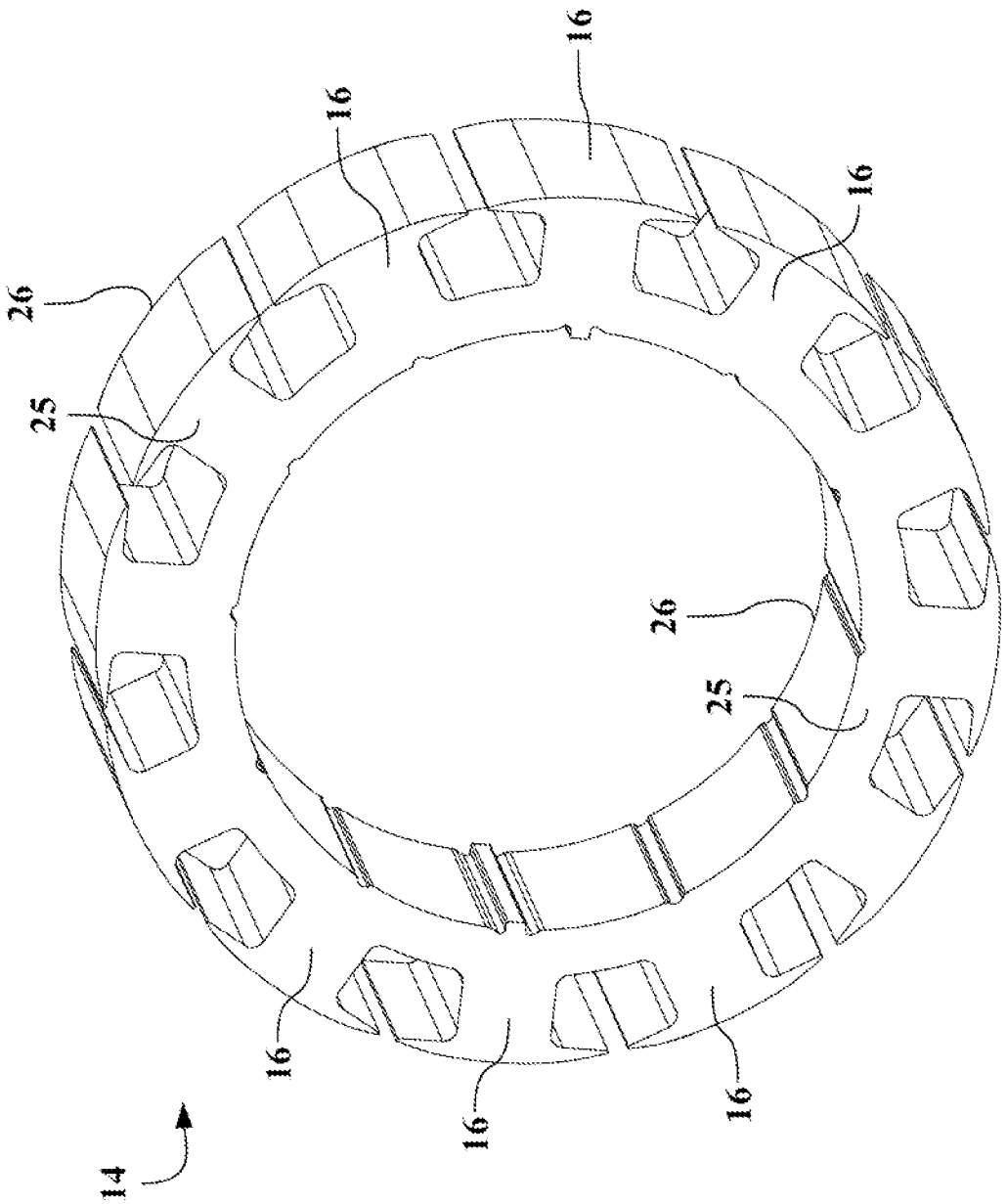

Figure 4

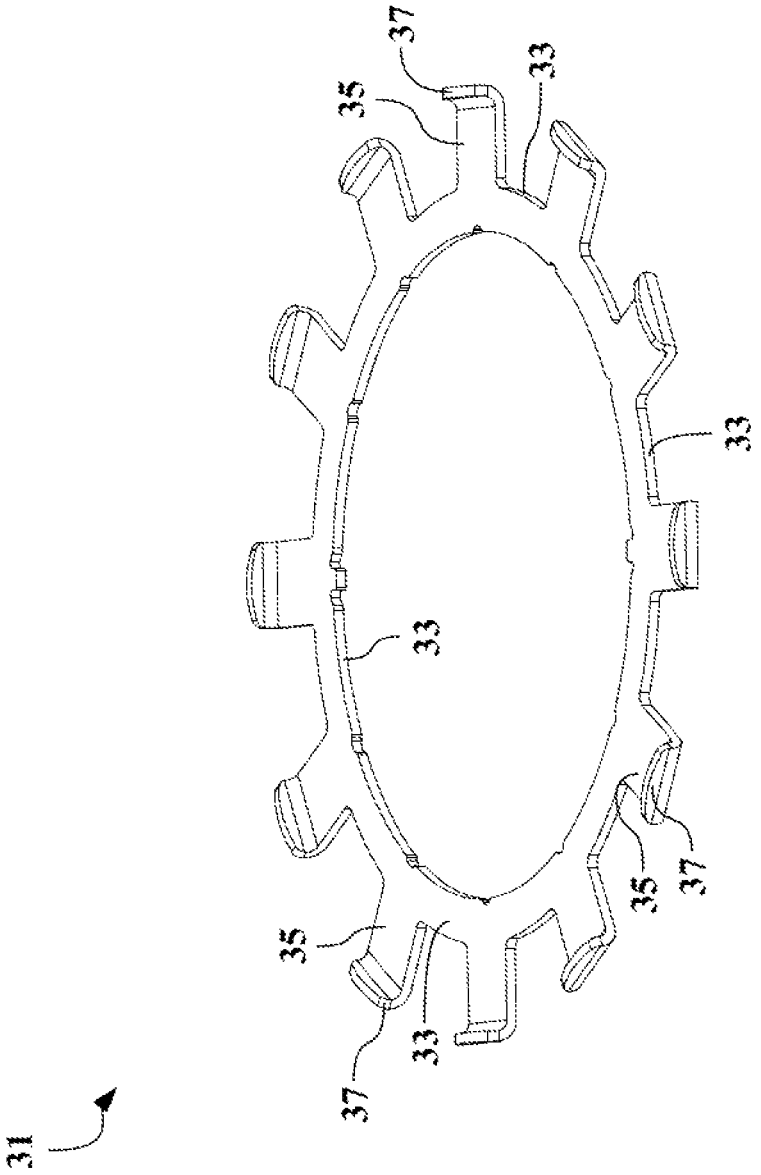

Figure 5

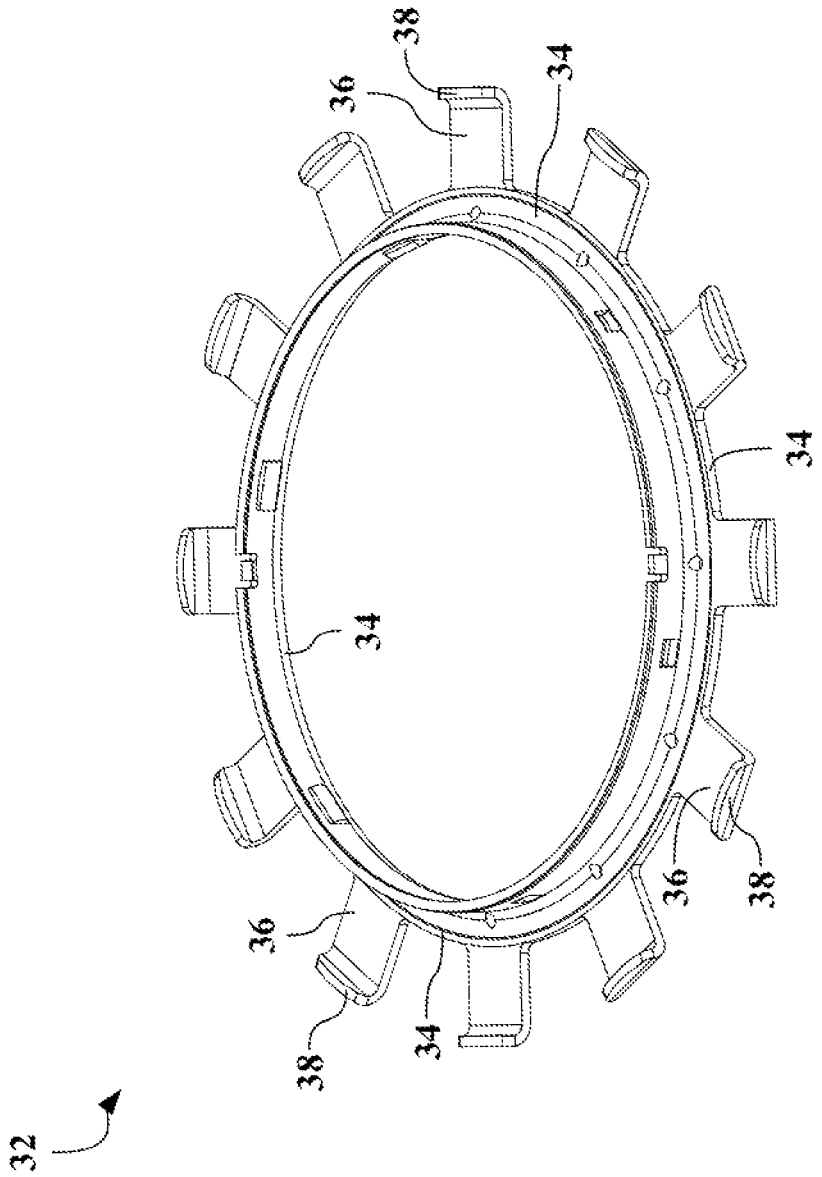

Figure 6

SUPPORT RING FOR ELECTRIC MACHINE ROTORS

TECHNICAL FIELD

This disclosure relates to wound rotors used in electric machines.

BACKGROUND

A stator is the stationary part of an electric machine. The stator interacts with a rotor, which is the moving or rotating part of the electric machine. The stator and rotor allow the electric machine to convert mechanical energy to electrical energy (generator mode) and to convert electrical energy to mechanical energy (motor mode).

SUMMARY

A support ring for a rotor, such as those used in electric machines, is provided. The rotor has a core and a plurality of windings. The support ring includes an annular base, a plurality of fingers, and a plurality of loaded edges. The plurality of fingers extend radially outward from the annular base, and each of the fingers generally corresponds to one of the windings. The plurality of loaded edges extend axially from the fingers and are disposed radially outward of the windings.

A rotor is also provided, and includes a hub, a core, and plurality of windings. The core is disposed radially outward of the hub, relative to an axis of the rotor, and has a plurality of rotor teeth extending axially outward. The plurality of windings are wrapped around the rotor teeth.

The rotor also includes a first support ring and a second support ring. The first support ring has a first disc, and a plurality of first fingers extending radially outward, and a plurality of first loaded edges extending axially from the first fingers. The second support ring has a second disc, a plurality of second fingers extending radially outward from the second disc, and a plurality of second loaded edges extending axially from the second fingers.

The above features and advantages, and other features and advantages, of the present invention are readily apparent from the following detailed description of some of the best modes and other embodiments for carrying out the invention, as defined in the appended claims, when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic, isometric view of a wound rotor;

FIG. **2** is a schematic, cross-sectional view of the rotor shown in FIG. **1** taken along line **2-2**;

FIG. **3** is a schematic, isometric view of the rotor shown in FIG. **1**, shown with a core hidden from view to better illustrate a first support ring and a second support ring;

FIG. **4** is a schematic, isometric view of the core of the rotor shown in FIG. **1**;

FIG. **5** is a schematic, isometric view of the second support ring of the rotor shown in FIG. **1**; and

FIG. **6** is a schematic, isometric view of the first support ring of the rotor shown in FIG. **1**.

DETAILED DESCRIPTION

Referring to the drawings, wherein like reference numbers correspond to like or similar components whenever possible throughout the several figures, there are shown in FIG. **1** and FIG. **2** two schematic views of a rotor **10**, which may be used in an electric machine (not shown). The rotor **10** shown in FIGS. **1** and **2** is an internal, wound rotor, which cooperates with an external stator (not shown) in the electric machine.

FIG. **1** shows an isometric view of the rotor **10**, substantially assembled.

FIG. **2** shows a cross section of the rotor **10**, taken along line **2-2** of FIG. **1**. Features and components shown in other figures may be incorporated and used with those shown in FIG. **1** and FIG. **2**, and components may be mixed and matched between any of the configurations shown.

While the present invention is described in detail with respect to automotive applications, those skilled in the art will recognize the broader applicability of the invention. Those having ordinary skill in the art will recognize that terms such as "above," "below," "upward," "downward," et cetera, are used descriptively of the figures, and do not represent limitations on the scope of the invention, as defined by the appended claims.

The rotor **10** includes a hub **12** and a core **14**, which has a plurality of rotor teeth **16**. The core **14** is disposed radially outward of the hub **12**, relative to an axis **18** of the rotor **10**. The core **14** shown is formed as a solid, one-piece core, but may alternatively be formed as a segmented core or as a laminated (axially-layered) core, and may be formed of powdered metal, cast, or machined.

The rotor **10** rotates about the axis **18** during operation of the electric machine. The stator of the electric machine would share substantially the same axis **18**. For cylindrical coordinates, in addition to the axis **18**, the rotor **10** also defines a radial direction, which extends perpendicularly outward from the axis **18**, and an angular axis or a tangential axis, which is in the direction of rotation about the radial direction. The rotor **10** may also use Cartesian coordinates, with the axis **18** being the z-axis, and also defining an x-axis (not shown) and a y-axis (not shown), both of which are perpendicular to the axis **18**.

The rotor **10** includes a plurality of windings **20** that are wrapped around the rotor teeth **16**, and extend axially beyond the core. The windings **20** are shown as a single block of material, but may be formed from wires or bar conductors that are then looped or twisted around the rotor teeth **16**.

Referring now to FIG. **3**, FIG. **4**, FIG. **5**, and FIG. **6**, and with continued reference to FIGS. **1-2**, there are shown additional views of various components of the rotor **10** shown in FIGS. **1-2**. FIG. **3** shows another isometric view of portions of the rotor **10**. However, in FIG. **3** the core **14** and the windings **20** are hidden from view to better illustrate a first support ring **31** and a second support ring **32** of the rotor **10**, which are described in more detail herein. FIG. **4** shows an isometric view of only the core **14**. FIG. **5** shows an isometric view of the first support ring **31**. FIG. **6** shows an isometric view of the second support ring **32**.

As best viewed in FIG. **3**, the rotor **10** also includes a plurality of bobbin segments or bobbins **22**, each of which substantially surrounds one of the rotor teeth **16**. The bobbins **22** may provide an insulating layer between the windings **20** and the rotor teeth **16**. The bobbins **22** may also provide structural support for the windings.

As best viewed in FIG. **4**, the core **14** defines a first axial side **25** and a second axial side **26** of the rotor teeth **16**. Designation as first or second may occur in any order and is not limiting of any specific component. The bobbin rings **22** are between the windings **20** and the rotor teeth **16** on the first axial side **25** and the second axial side **26** of the core **14**. On

the side of the hub **12** adjacent to the first axial side **25** of the core **14**, an annular shelf **28** extends radially outward from the hub **12**.

The rotor **10** includes the first support ring **31** and the second support ring **32**. As shown in FIG. **3**, the first support ring **31** and the second support ring **32** are disposed on opposite sides of the core **14**, axially. The first support ring **31** and the second support ring **32** are in contact with at least the hub **12**, and may also be in contact with the core **14** and the bobbins **22**, as shown in FIG. **2**.

The first support ring **31** includes an annular base or first disc **33** and the second support ring **32** includes a second disc **34** or annular base. The first disc **33** and the second disc **34** are in contact with the hub **12** and are configured to transfer loads from the first support ring **31** and the second support ring **32** to the hub **12**.

A plurality of first fingers **35** extend radially outward from the first disc **33**, and a plurality of second fingers **36** extend radially outward from the second disc **34**. In the configuration of the rotor **10** shown in the figures, each of the first fingers **35** corresponds to one of the windings **20** and is generally aligned with one of the rotor teeth **16**. Similarly, on the opposing side of the core **14**, each of the second fingers **36** corresponds to one of the windings **20**. For the rotor **10**, the first support ring **31** and the second support ring **32** are not identical but do share many similar features.

As best viewed in FIG. **3** and FIG. **5**, a plurality of first loaded edges **37** extend axially from the first fingers **35** of the first support ring **31**. The first loaded edges **37** are disposed radially outward of the windings **20**, such that radial loads from the windings **20** are transferred—at least partially—to the load edges **37** of the first support ring **31**. Similarly, a plurality of second loaded edges **38** extend axially from the second fingers **36** and are disposed radially outward of the windings **20**, such that radial loads from the windings **20** are transferred—at least partially—to the load edges **38** of the second support ring **32**.

The first loaded edges **37** and second loaded edges **38** are cantilevered from the first fingers **35** and the second fingers **36**, respectively, in the configuration of the rotor **10** shown. However, other shapes may be used to allow transfer of radial loads from the windings **20** to the first support ring **31** and the second support ring **32** and, therefore, to the hub **12**. For example, and without limitation, the first loaded edges **37** and second loaded edges **38** may also be formed with a rounded or hooked shape (i.e., similar to a shepherd's hook or a candy cane) extending from the first fingers **35** and the second fingers **36**, respectively. Additionally, the first loaded edges **37** and second loaded edges **38** need not be identical.

Radial loads are transferred from the windings **20** to the bobbins **22**. Without the first support ring **31** and the second support ring **32**, all of the radial loads from the winding **20** would be transferred to the rotor teeth **16** and the core **14**—possibly through the bobbins **22** as an intermediary. However, the first support ring **31** and the second support ring **32** absorb or react some of the radial loads from the windings **20**. This configuration reduces and distributes the loads transferred to the bobbins **22** and the rotor teeth **16** of the core **14**.

In the configuration of the rotor **10** shown, the first fingers **35** are disposed between the windings **20** and the first axial side **25** of the rotor teeth **16**, and the second fingers **36** are disposed between the windings **20** and the second axial side **26** of the rotor teeth **16**. Furthermore, the bobbins **22** are disposed between the windings **20** and the first and second fingers **35**, **36**. Therefore, radial loads from the windings **20** are transferred first to the bobbins **22** and then to the first and second fingers **35**, **36**.

The first support ring **31** may be formed as a unitary component, such that the first disc **33**, the first fingers **35**, and the first loaded edges **37** are formed as one piece. Furthermore, the first support ring **31** may be a stamped component. Similarly, the second support ring **32** may be stamped as a unitary component, such that the second disc **34**, the second fingers **36**, and the second loaded edges **38** are formed as a one-piece stamping.

The first support ring **31** and the second support ring **32** may be formed from substantially-nonmagnetic materials. If the first support ring **31** and the second support ring **32** are substantially nonmagnetic, the first support ring **31** and the second support ring **32** may not alter the magnetic response of the windings **20** during operation of the rotor **10** in the electric machine. The bobbins **22** may also be formed from nonmagnetic or insulating materials. For example, and without limitation, the bobbins **22** may be formed from resin and the first support ring **31** and the second support ring **32** may be formed from stainless steel.

For the rotor **10** shown, the second support ring **32** may be press-fit onto the hub **12**. Therefore, the first support ring **31** is trapped between the annular shelf **28** and the first axial side **25** of the core **14**. Then the second support ring **32** is press-fit onto the hub **12**, such that the second support ring **32** traps the core **14** and the first support ring **31** against the annular shelf **28** of the hub **12**.

The detailed description and the drawings or figures are supportive and descriptive of the invention, but the scope of the invention is defined solely by the claims. While some of the best modes and other embodiments for carrying out the claimed invention have been described in detail, various alternative designs and embodiments exist for practicing the invention defined in the appended claims.

The invention claimed is:

1. A rotor, comprising:

a hub;

a core disposed radially outward of the hub, relative to an axis of the rotor, and having a plurality of rotor teeth extending axially outward therefrom;

a plurality of windings wrapped around the rotor teeth;

a first support ring, having:

a first disc,

a plurality of first fingers extending radially outward from the first disc, wherein each of the first fingers corresponds to one of the windings, wherein the first fingers are disposed between the windings and a first axial side of the rotor teeth, and

a plurality of first loaded edges extending axially from the first fingers and disposed radially outward of the windings; and

a second support ring, having:

a second disc,

a plurality of second fingers extending radially outward from the second disc, wherein each of the second fingers corresponds to one of the windings, wherein the second fingers are disposed between the windings and a second axial side of the rotor teeth, and

a plurality of second loaded edges extending axially from the second fingers and disposed radially outward of the windings.

2. The rotor of claim **1**, further comprising a plurality of bobbin rings, wherein each bobbin ring substantially surrounds one of the rotor teeth.

3. The rotor of claim **2**, wherein the bobbin rings are disposed between the windings and the first and second fingers.

4. The rotor of claim **3**, wherein the first support ring and the second support ring are substantially nonmagnetic.

5. The rotor of claim 4, further comprising an annular shelf formed on the hub,

wherein the first support ring is trapped between the annular shelf and the first axial side of the core, and

wherein the second support ring is press-fit onto the hub such that the second support ring traps the core and the first support ring against the annular shelf.

6. The rotor of claim 5,

wherein the first disc, the first fingers, and the first loaded edges of the first support ring are formed as a one-piece stamping, and

wherein the second disc, the second fingers, and the second loaded edges of the second support ring are formed as a one-piece stamping.

7. The rotor of claim 1, further comprising an annular shelf formed on the hub,

wherein the first support ring is trapped between the annular shelf and the first axial side of the core, and

wherein the second support ring is press-fit onto the hub such that the second support ring traps the core and the first support ring against the annular shelf.

8. The rotor of claim 7, further comprising a plurality of bobbin rings, wherein each bobbin ring substantially surrounds one of the rotor teeth.

9. The rotor of claim 8, wherein the bobbin rings are disposed between the windings and the first and second fingers.

10. The rotor of claim 1, wherein the first support ring and the second support ring are substantially nonmagnetic.

11. The rotor of claim 10,

wherein the first disc, the first fingers, and the first loaded edges of the first support ring are formed as a one-piece stamping, and

wherein the second disc, the second fingers, and the second loaded edges of the second support ring are formed as a one-piece stamping.

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